Group decision making in oncology: A support through annotation management

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Abstract: We propose a software prototype based upon annotations management in palliative ward of an oncology hospital in which dealing with patients' state and evolutions is a complex organizational task. We develop a 5 years empirical investigation that is giving us broad and deep insights to characterize activity and offer an effective support for group decision making and collaborative activity of caregivers. We based our conception of annotation tool on the observations of the rich writing practices of medical professionals. We rely on the innovative strategy of intermediate management to introduce a new technology able to bridge heterogeneous valuable data flows that address both management support and activity support into a single tool.

Keywords: annotations management, complex tasks, caregivers' coordination, data flows management.

1 Annotations to handle complex environments

Our main research topic consists in the understanding and the computer support of organizing processes in uncertain, fast changing and complex environment [1]. We conduct an empirical and qualitative research in a palliative ward of an oncology hospital for more than 5 years. This led us to consider annotation practice and annotative process (to be defined thereafter) as the core elements of organizational work of caregivers in the ward to grab complexity and coordinate collective action in this highly evolving environment. We present in this paper a tool based on annotations management that we conceived for group decision making and for the support of work organizing practices.

In the first part of this paper, we will present a pluridisciplinary state of art about annotations management and about the relationships between writing practices, group decision making and negotiated collective work. We will develop our functional tool prototype for the organizing work in oncology based upon annotations. And finally, we will conclude and open discussion toward opportunities and limits of such an approach of collaborative decision support system.

2 Annotations and their management: state of art

Theoretically, we rely upon the Montreal school of text conversation model to address organizations and organizing process [10]. We also use Weick's concept of "*mindful interdependence*" to interpret specifically the way caregivers mobilize and act into an interconnected network of human and non human resources and actors to produce resilient and robust organization despite organizational complexity [11]. This theoretical frame is suitable to understand and analyze the intertwinement between texts production, oral communication, organization, technologies and patients management that we observe in our research ground.

While acknowledging flexibility, ease of use, but also hermeneutic and heuristic abilities of annotations, scientific communities that are involved with these practice-tools consider them in all our readings as a phenomenon. Annotation practice emerges due to complex environments, due to the "lack" of memory of workers, due to rigidity of formal and numeric documents. They are often pointed as a pragmatic response to complexity but they are never used as the core element of organizing processes [5, 8, 12]. Annotations are perceived as peripheral and secondary elements, which purpose is to enrich or interconnect texts or objects, to memorize temporary information or remember something to do. Annotations have been often described as structuring tools at a micro social level [5, 8]. Their features enable them to support cooperation and coordination modalities of small collectives of work. Annotation considered as a practice allows caregivers to capture quickly and easily relevant events in organization and care activity, to sort and synthesize elements (writer/reader dependant), to discuss specific elements during transmissions, to make hypothesis, to give instant access to these items through various medias [2], and to distribute collective awareness and watchfulness between members of the collective.

Annotations have the ability to interconnect and integrate synthetically various data sources and to assemble heterogeneous organizational elements (Fig 1.) (EPR, EMR[1], oral transmissions, artifacts of environment, scheduling,…). Annotations offer flexibility and ease of use that permit to answer to the milfoil of action modalities, superposed temporal constraints (physicians visits, patients' care, patients entry or exit, …), distributed data and complexities of situations in palliative ward [9].

From the reader point of view, annotations embark various "functionalities": todo lists, reminders, questions, interpretations, thoughts. They activate specific watchfulness thanks to writing modality (color, forms, underlining, "anchor"). Annotation is a powerful tool used to characterize, to remind, to coordinate, to develop *aboutness* and finally to manage patients' care context that contains many interweaved dimensions: medical, social, temporal, technical, cognitive, regulatory, organizational, and so on.[8]

From an organizational point of view, annotation practice that we observe in our research ground can be seen as a cultural practice that structures and configures organization of care work as much as it shapes the sociotechnical collectives [3]. As annotations are extracted from patients' context, negotiated and then put back in the

[1] Heath Information System, Electronic Patient Record, Electronic Medical Record

patients' history and trace into HIS bricks, they co-configure writing practices, as much as they are part of the group decision process as involved and "*agentive*" actors.

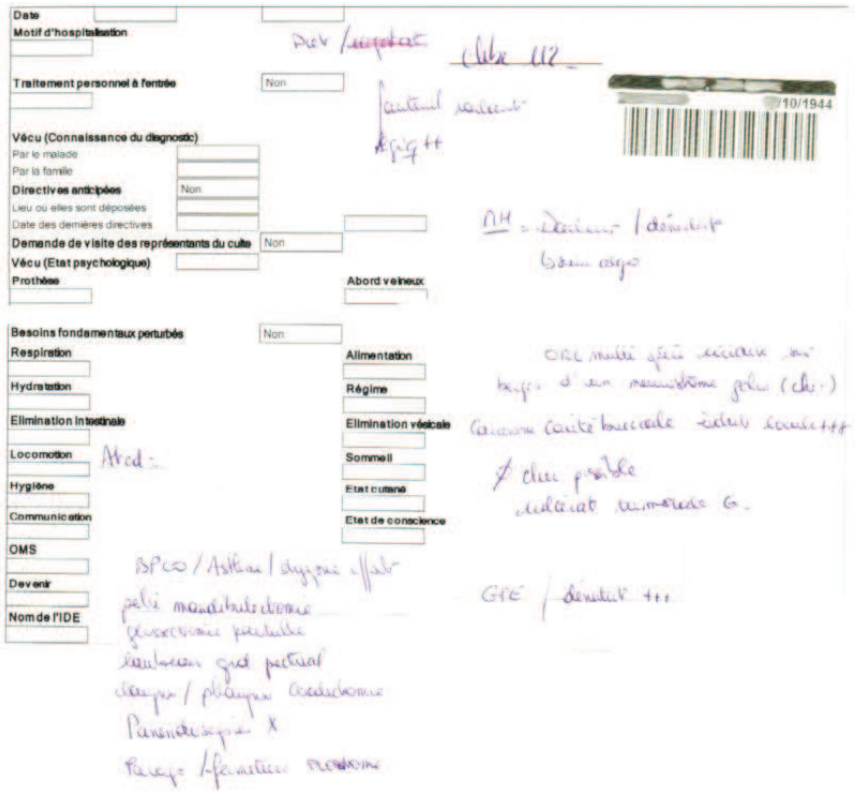

FIG. 1. The annotative practice: a nurse printed a patient entrance form (heuristic flow), added the room number and stuck patient barcode (institutional flow), added handwritten notes with data extracted from EMR (institutional flow) plus personal notes in order to plan further action (interview of patient and gathering of up to date data).

Finally, annotations can be seen as micro stories that are told and re-told many times a day by different spokesman in order to verify every piece of information about patients. It's a very collective work of *informational forge* which gives consistency to data, to patients' stories and trajectories, and to group decision that validates or invalidates parts or sometimes the entire therapeutic plan.

2.1 Annotations as the core of organizing processes: the annotative practice

Despite the huge amount of intrinsic qualities of annotations that our literature review and our ground observations point out, still the annotations are considered as second order elements, useful, but not as key objects of concern for group decision support or CSCW field. By now, we will formulate the hypothesis that annotations can be

considered opportunely as constitutive elements – no more peripheral – in the production of documents and in the forge of organizational texts. Beyond documentary features, we will also characterize them as elementary bricks that are constitutive elements in the organization of medical work that is closely tied to text production that intervene in manage patients' pathology, trajectory and care [3]. Annotations are core elements of everyday practice of organizing in oncology ward. Caregivers rely on what we could call and characterize as an "*annotative practice*" to handle their complex environment of work and the complex situations of patients they take care of. This "*annotative practice*" deals with three *valuable* data flows (Fig 2.).

- The institutional flow mediated by EPR and EMR. This flow is impelled by professional regulatory constraints. It is often composed of a huge amount of exhaustive technical documents related to patients' history, disease, laboratory tests, imagery,... This flow is difficult to handle and use in everyday activity due to the *encyclopedic view* of patients that it provides. Hospital organization risk financial penalties if the quality and completeness of this flow is insufficient with regard to the law.
- To the *other side* of document valuable flows, we observe personal writings or very small collective writing flows, mediated by printed sheets heavily annotated during work. This flow can also be embedded in various artifacts (drug packing, sticky notes). This is the core flow of what we call the annotative practice. Caregivers literally rebuild a very rich and situated set of data to grab the world, understand the situations and act into the complex environment of palliative ward. This flow has two main inconvenient. It is hard to normalize due to personal practice of writing and it is produced outside HIS.
- The third flow we were able to observe is the result of an innovation driven by intermediate management of the palliative ward in order to articulate the two valuable flows depicted above. The caregivers in the ward developed iteratively a collective flow mediated by heuristic documents. This flow offers a synthetic view of all the patients in the ward in 2 page of A4 format. This text sheet is managed by the nurses of all the teams with a standard text editor and stored into a local file on the ward computer. This document is printed and annotated during work and used for oral transmission during team shifts.

These three valuable data flows act in different layers of the organization (institutional, collective, individual) but they are not independent from each other. Each flow is correlated to each other and produces either a frame or a complement to the others flows. These flows help caregivers in awareness and decision making, for therapeutic adjustment, and for the articulation, coordination and cooperation in the realization of the multiple and complex tasks they have to operate to take care of patients. These flows are melted all together thanks to document manipulation and during team shifts transmission. As these flows are produced by heterogeneous sources and contain both redundant and complementary data, caregivers *normalize* data flows by what we call an *annotative practice*. Caregivers use sort of *pivot format* namely annotations to mix and reshape heterogeneous data for their individual and collective purpose and then put data back into the right destination flow.

Thereby, we consider that organizing work is correlated to communicational processes mediated by and embedded in writing practices that are *co-constitutive of organization* [10] and that produce a network of *mindful interdependence* [11].

Our goal in the design of our prototype is to rely upon caregivers' innovative practice and to articulate these three valuable flows that address various organizational requirements into a single tool based on annotations.

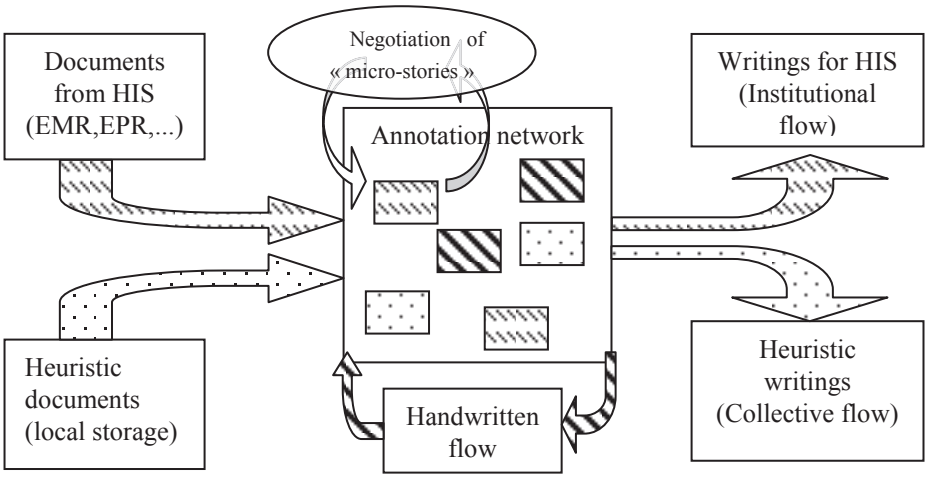

Fig. 2. Valuable flows and annotative practice cycle: Documents are split into handable pieces connected to each other (author, subject or target). Each piece is negotiated during team shift transmissions. Negotiated pieces are stored into a collective form and the cycle restart.

3 From empiric approach to software prototyping

When we take a look at tools such as social networks, participative conception tools, workflow modeling systems or ERP, users have the ability to define models of activity, plan actions, lists and organize tasks, make storytelling. But until now, the layer of organizing as we have presented is often neglected. *Tools on shelves* are often proposed as "*system as is*" from requirements engineering perspective[7]. But what we have learned from our empirical investigation and from our readings is the fact that in everyday situations technical systems are both *system as is* and *system to be*. Tools shape practices as well as they are shaped by repeated practices and experiments of caregivers. The only "*independent variable*" that we were able to point out, is in fact the annotative practice that we have just described. So, in order to reach the needs of caregivers and the requirements of standards, HIS and regulatory constraints, we need to go beyond the limitations of these tools and standards [4]. This is why we populate the organizing layer with "smart" annotations that reproduce writing practices and document forging practice of caregivers and why we also develop a prototype which is "system to be" that caregivers can design by themselves. Thanks to its functionalities, our tool can participate both in institutional and ambient organizing, offering flexibility, instant access, ease of use and more importantly

robustness and resilience for the organization of medical activity. This overlay allows caregivers to articulate heterogeneous sources of data into a single "blender" in order to build a situated informational system connected to and interoperable with the institutional one. To address these issues, our tool provides three main functionalities. It first gives the ability to split documents of all kind into annotations network with references of original document. Then caregivers can manage organization of work and data through a connected network of "smart" extended and connected annotations. Finally, they can create composite tools above the annotation layer to give usable shapes to annotations network. Due to this article format, we will only develop annotation management.

3.1 Annotation modeling:

Annotation is the core object of our prototype. In other words, all the objects and class related to data flows management are extended from annotation class; annotation is the constitutive class of our application.
As annotations have the ability to transform objects into a single pivot format of data, we have to design them to be compatible with usual objects of writing practices, organizing and communicational processes. For example, we equip our annotations with event management features (begin/end date, repetition,…), messaging features (author/sender, recipients, attachments) or search / autocompletion abilities.
Here is the non exhaustive list of features of these smart annotations (Fig 3.).

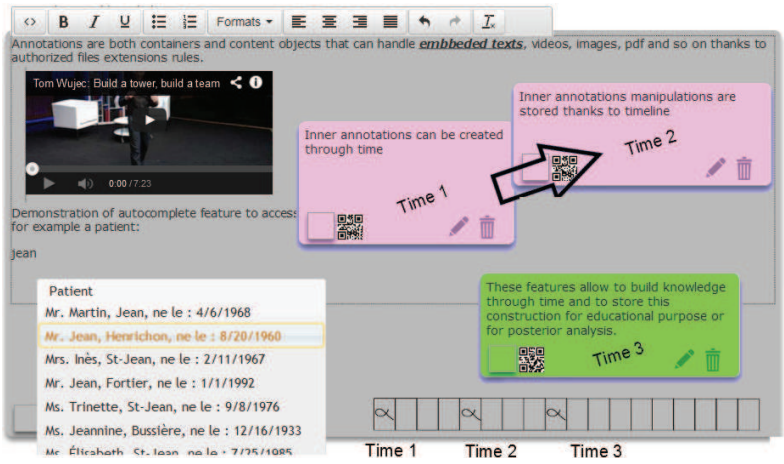

Fig. 3. Screenshot of annotations that illustrates some of their smart functionalities: multimedia container, cross reference preservation and autocompletion. Inner "timeline" holds synchronous or asynchronous updates of annotation content (versionChild) and inner annotations state.

Editing abilities of annotations:

- Annotations can handle content style layout (thanks to a wysiwyg editor)
- Annotations supports drawings (through a svg editor)

- They have an auto-complete feature which can connect them to external nomenclature (medical, equipment, patients or caregivers directory,…)
- They have a spellchecker functionality that allows caregivers to access various dictionaries, generate popup glossary and handle local vocabulary (in order to build local acronyms and maintain ontological reference to a term).

Containing abilities:

- Multimedia container ability (text, html, images, videos, attached content)
- Self containing: an annotation can hold and be held into an annotations net
- Have an inner timeline that manages internal states evolutions.
- Support multi-authoring.

Annotation model characteristics and class diagram:
We rely on the work of the OAC workgroup (Open Annotation Collaboration) paradigm for annotations model. We use this general frame for our annotation model in order to be compliant with web standards of connected objects and medical document standards (HL7) so to prepare our prototype for further integration (Fig 4.).

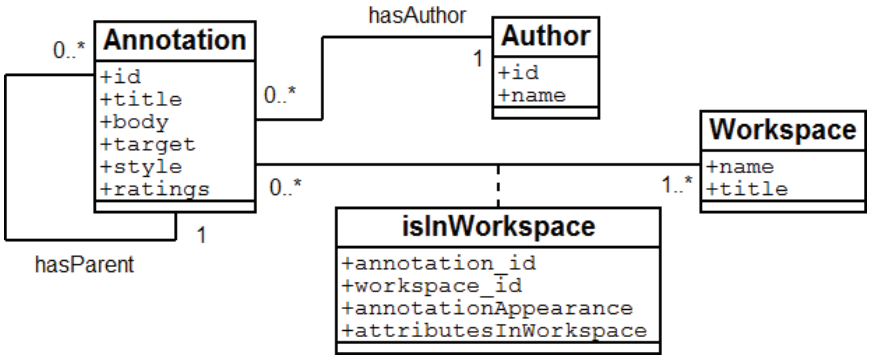

Fig.4. Simplified annotation class diagram.

Our contribution to these standards stands in the fact that our annotations embark: versioning, rich media management, "smart" data contextualization through nomenclature and dictionary connections, and internal timeline.

4 Conclusion

We proposed in this paper a new paradigm for group decision making and collaborative work support in oncology ward: the constitutive role of annotations to address organizational complexity and manage heterogeneous valuable data flows.

Our contribution to the domain relies in the proposal of enhanced functionalities of annotations based on deep observation of writing practices. Our proposal argues that translating this practice into a software design is full of interesting potentialities for

group decision support domain. This allows to maintain a structuring, organizing and constitutive practice, and to build robustness and resilience by the intensive everyday usage of writing tool and the co-creation process that we observed [6]. The stake in our proposal is to go beyond annotation tools as a collaborative tool for collective writing. We propose to equip classical HIS with a layer of organizing based upon annotations to manage valuable flows of data and co-create organizing and mindful interdependence. This construction could help caregivers to build a culture of interoperable writings that both match activity needs and normative standards of medical documents. Hence, our tool could help to build a richer and extended writing culture toward professionalization of medical writings. For now, the prototype is under development and the tests step with real end-users is until yet not feasible.

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